



# FORTA-FI

Fiber Reinforcement  
For Asphalt

Fiber Reinforced Asphalt for Longer Lasting,  
More Cost Effective Overlays

"LEANER - MEANER - GREENER"

Presented By: Joe Sturtevant, P.E.

NW Pavement Management Conference

October 24<sup>th</sup>, 2012



"We've got a biased salesperson saying it's going to save money"  
Jason Anderson, Medford Water Commission

"Sales Guy" or Credible Solutions Provider?

# Says Who?

## Joe Sturtevant Background

B.S. Civil Engineering  
Professional Engineer  
Sturtevant, Golemo, & Assoc.  
Contech Engineered Solutions  
JAS Company

**20+ Years Civil Engineering  
Career**

Expertise: Roadway Infrastructure  
and Pavement Technologies

## Forta Corporation

U.S. Company  
+ American Ingenuity  
+ Made in America  
1978 Started with Fiber  
Reinforcement for Concrete  
Researched and Developed  
Forta-Fi over 30-year period

# FORTA-FI fiber-reinforced asphalt



## Substantial cost savings

- Saving money and improving infrastructure go hand-in-hand with the use of FORTA-FI



## Proven effective

- University, DOT, and Industry projects/testing worldwide



## American Ingenuity

- Engineered and made here to solve the problems we face... and to keep America(ns) moving forward

# Cost Savings & Sustainability

Immediate cost savings, (*35% reduction in asphalt thickness*)









Extended cost savings, (*>50% longer asphalt life*)



You choose which type of savings best meet your needs

# Cost Savings & Sustainability

## Additional savings & green benefits

- Future cost of money
- Less traffic interruption
- Lower operating costs such as fuel expenditures 
- Fewer trucks needed per job 
- Fewer man/machine hours to place and compact 
- Shorter projects 
- Less maintenance and resurfacing 
- Less asphalt 

# Proven Effective

Extensively tested over 30 year history

- University of TX, mid 80's
- Arizona State University, currently
- South Dakota School of Mines and Technology, currently
- Auburn University Test Track, currently
- Numerous private/industry testing labs
- Internationally
  - Czech Republic
  - Spain
  - Turkey
  - Russia
  - Pakistan
  - The Netherlands
  - ...and more



# Proven Effective

Not just tested,  
but proven

- Successful projects around the globe
- Each presented unique challenges where typical asphalt was not enough
  - Airports
  - Heavily rutted roadways
  - Severely cracked roadways
  - High traffic volume made full reconstruction difficult
  - Etc.



# Proven Effective...

## Tough Jobs

- Jackson Hole Air Port, unique challenges
  - 1 1/2" porous friction course
  - Located in Grand Teton National Park
  - 35,000 flights annually, >300,000 emplanements



# Proven Effective...

## Tough Jobs

- 6,450' elevation forces higher speed landings
- 6,300' length forces more braking for larger aircraft
- 300" of snow annually, and constant snow plowing
- Temps range from -40F to 104F seasonally
- Already shown 50% increase in longevity in just 3 years



2012, three years later



2012, three years later



2012, three years later





# Proven Effective...

## Pie Crust Roadway - (*Swamp Road*)

- Chisago County, Minnesota, October 2009
  - 1 1/2" wearing course over badly cracked and rutted base
  - Very unstable base subject to numerous freeze/thaw cycles annually



# Proven Effective...

## Pie Crust Roadway - (*Swamp Road*)

- Full reconstruction not possible due to budget
- Typically milled and repaved every two years
- One control lane, and one lane with FORTA-FI





# Proven Effective...

## Pie Crust Roadway - (Swamp Road)

- Project reviewed at 20 months and 30 months
  - Control lane shows significant rutting and cracking
  - FORTA-FI lane has no cracking, no rutting!
  - Cracks actually stop at FORTA-FI lane!
  - Already shown 100% increase in longevity in less than 3 yrs



# Proven Effective...

Demonstrated through a failure!

Boeing – Mesa, AZ

- Flightline infield placed in 2008
- 2010, broken pipe caused a sink 2 ½' W x 8' L x 3" D
- Forta-Fi held pavement together and there was no cracking



# Proven Effective...

Demonstrated through a failure!

Aspha

- One
- Ren

Thick





# American Ingenuity



Engineered and made here to solve the problems we face...

- No other country has more miles, or more demanded from its system of roadways
- There are thousands of unique asphalt designs, and thousands of different design factors, (traffic, climate, local soil, available aggregate, etc.)

# American Ingenuity



## Made in America

- American company, helping put Americans to work, and keeping America moving forward

# Product History

## FORTA-AR

- Originally developed 1982
  - Used on a number of Domestic & International projects
- Key benefit
  - Reinforcing fibers designed to add life to asphalt, (difficult to quantify)
- Testing
  - University of Texas at Austin, 1986
- NEED HAD NOT FULLY DEVELOPED

# NEED : “Falling Apart and Falling Behind”

- 94% of Roads are Asphalt
- Constructed with Old Methods
- Deterioration/Failure
- Less Funding
- More Traffic
- Heavier Loading
- Diminishing Materials
- Asphalt Cost Increase
- Rock Cost Increase
- Shift to Preservation



**Can't keep doing the same things!**





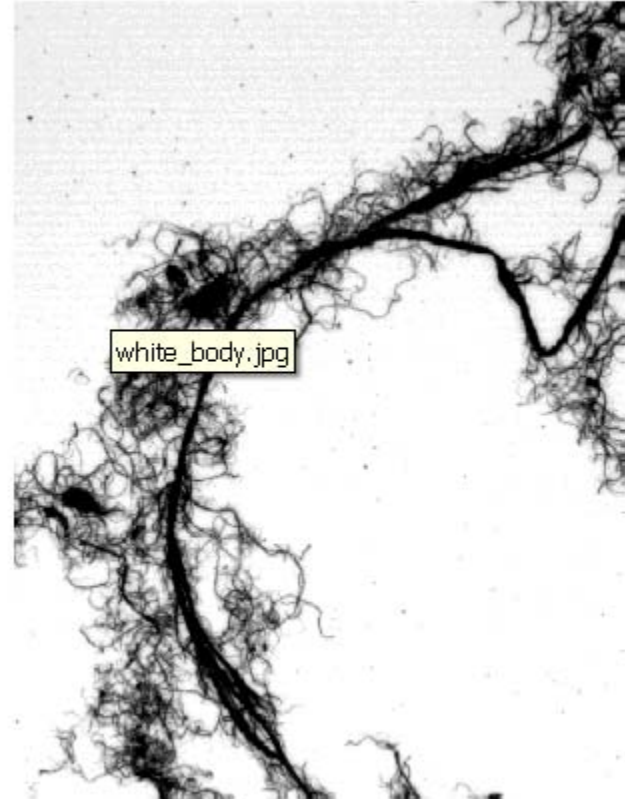
**True sustainability means not only seeking new ideas, but searching for innovative alternatives to existing methods.**

# Product Redeveloped

## FORTA-FI

- Launched in 2008
- Key benefits
  - Cost savings, immediate or long term or both!
    - Reduce asphalt thickness by 35%
    - Extend service life of asphalt by more than 50%
    - Reduce Cracking, Rutting, and Raveling
- New testing - MEPDG
  - Arizona State University, 2008 & 2009
    - Incredible results
- Developed Delivery & Mixing System

# Forta-Fi – Kevlar Strength



- VERY High Tensile Strength
- Non-Corrosive
- High Temperature Resistance



# Forta-Fi – Kevlar Strength



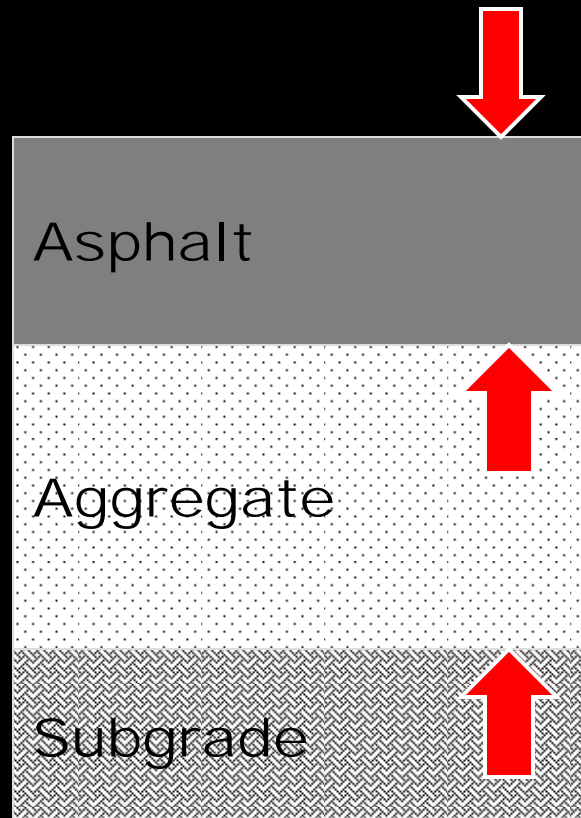
## Standard Asphalt

- Asphalt is “Rocks & Glue”
- Low Tensile Strength
- Temperature Susceptible
  - Rutting / Cracking
- Chemical Bond
- Bitumen Breaks Down

## Forta-Fi Characteristics

- Fibrous Tensile Solid
- “Roots” Grab Asphalt Particles
- Binds Asphalt Particles
- Temperature Resistant
- Buddies with Bitumen
- Stops & Controls Cracks

# Typical Pavement Distresses



## Top Down Stresses

Loading  
Sun/Rain  
Thermal  
Freeze/Thaw  
Oxidation

## Distress

Cracking  
Rutting  
Raveling

## Bottom Up Stresses

Joints / Cracks  
Weak Soil  
Drainage  
Freeze/Thaw

## Distress

Cracking  
Rutting  
Pot Holes

# Evaluation of FORTA Fiber-Reinforced Asphalt Mixtures Using Advanced Material Characterization Tests

**Dr. Kamil E. Kaloush - 2008**

**Tests Performed:** Triaxial Shear, Mohr-Coulomb, Permanent Deformation, Repeated Load, Dynamic Modulus, Fatigue Cracking, Flexural Strength, Thermal Cracking, Fracture Energy, Crack Propagation, Fiber Extraction.

- 15 x resistance to Deformation
- 100% Higher Dynamic Modulus at 100F
- 150% Higher Tensile Strength
- 100% Increase in Fracture Energy
- 30% Reduction in Raveling
- 2" Overlay Modeled in MEPDG Program: 50% Increase in Service Life



“Forta fiber reinforced asphalt mixture performs better than the control mixture against Rutting and Fatigue irrespective of the thickness of the AC layer”. Dr. Kaloush

# Use of Fiber Reinforced Asphalt Concrete as a Sustainable Paving Material for Airfields

Stempihar - Souliman - 2011

**Tests Performed:** Dynamic Modulus, Fatigue Cracking, Indirect Tensile Strength, Cantobro Abrasion, CO2 Equivalent Emissions Comparison.

- **Pervious Pavement**
- **Modulus Increase 5% at 40F, 200% at 100F**
- **Fatigue cycles increase 60%-500% over control**
- **Fracture Energy increase 50% over control**
- **Increased raveling resistance 30% over control**
- **GHG reduction of 33% over current practice**

“Based on...performance test results from the Jackson Hole Airport FRAC mixture, ...(overlays) may be an excellent candidate to receive polypropylene and aramid fiber reinforcement to improve engineering properties and ultimately, service life”

# Science Details

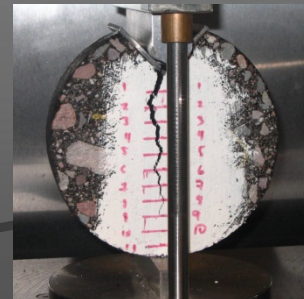
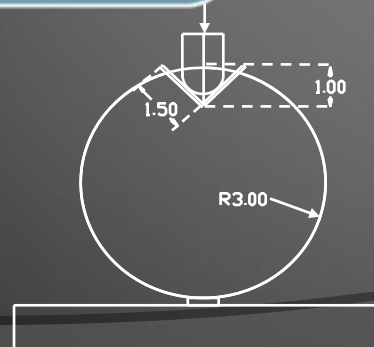
## Cracking Evaluation



### Cracking

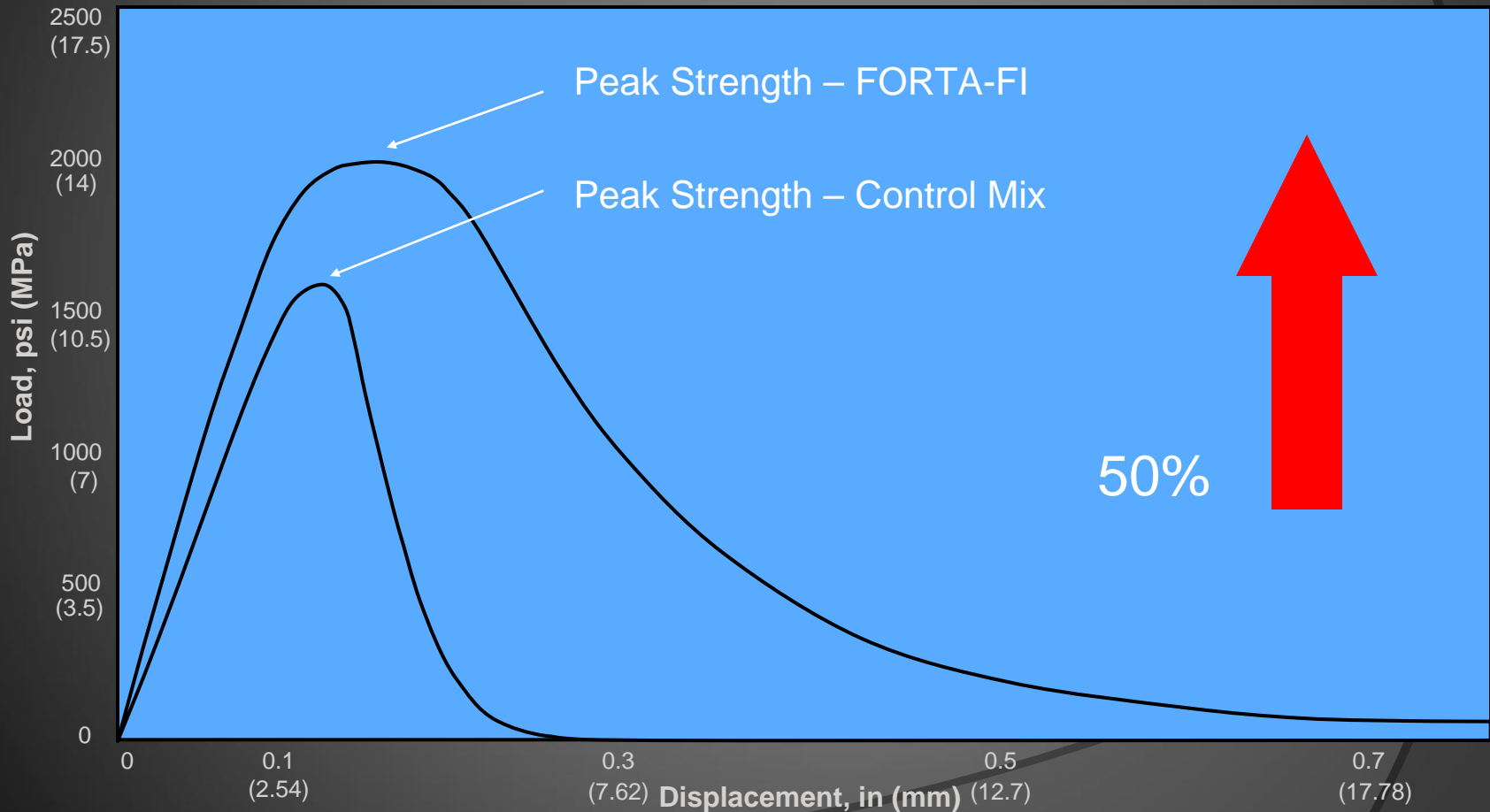
- Fatigue- *repetitive loading (traffic, thermal)*
- Reflective- *joint, crack or under layer defect*
- Thermal- *expansion/contraction due to temperature (gradients are never uniform)*

C\* Integral Crack Propagation test, similar to Superpave Indirect Tensile Test (IDT)



# Science Details

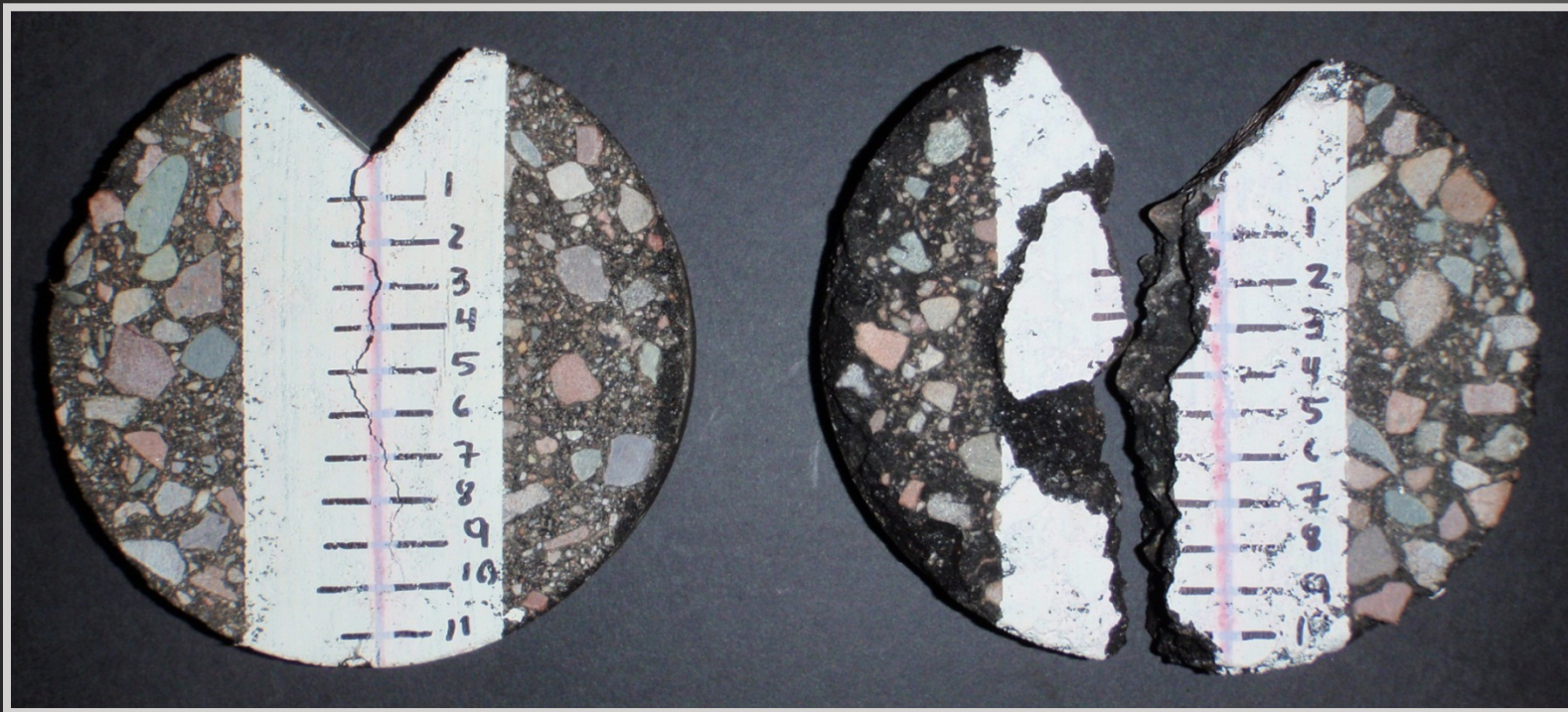
## Cracking Evaluation – Peak Strength





# Science Details

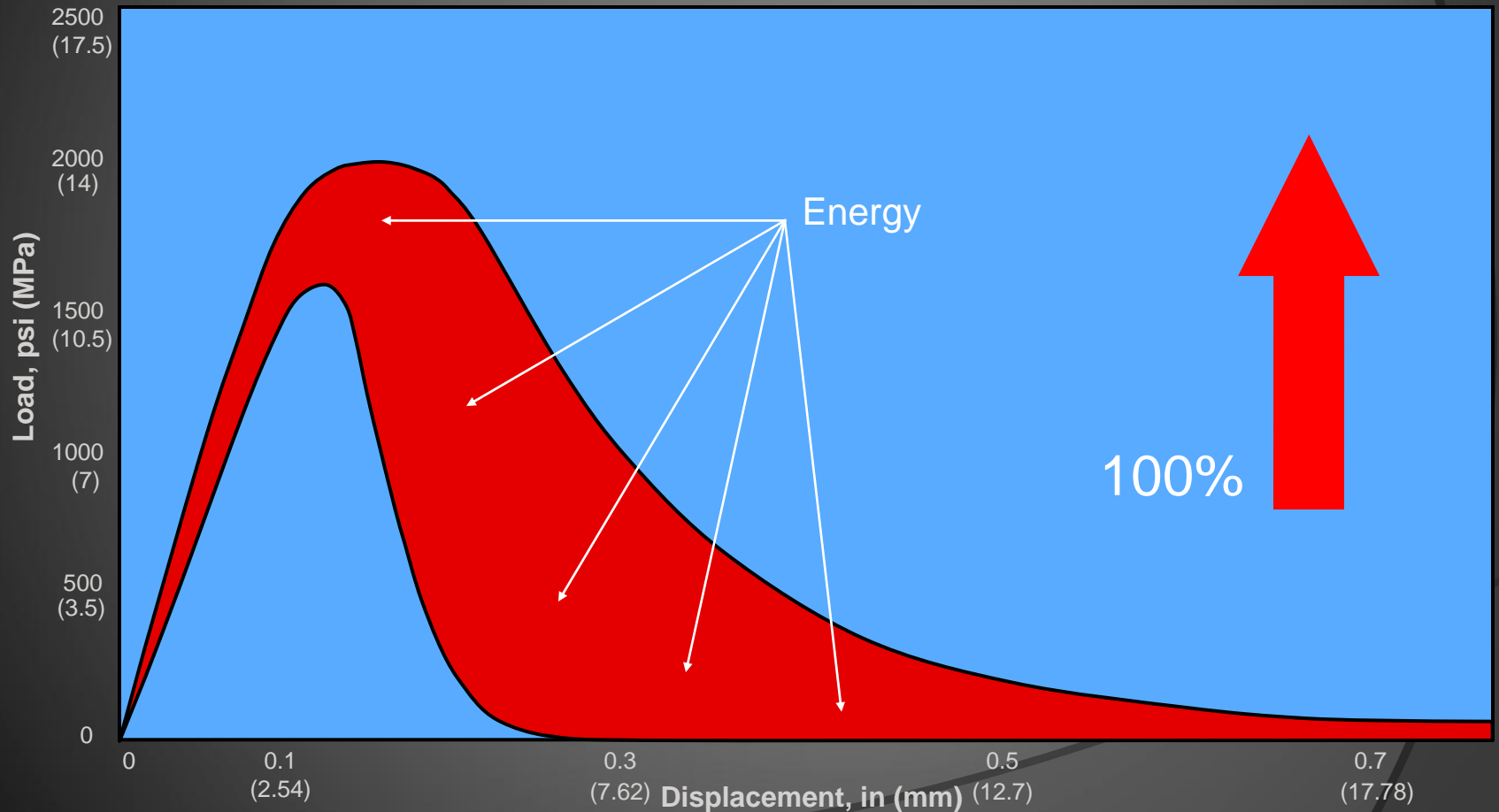
## Cracking Evaluation





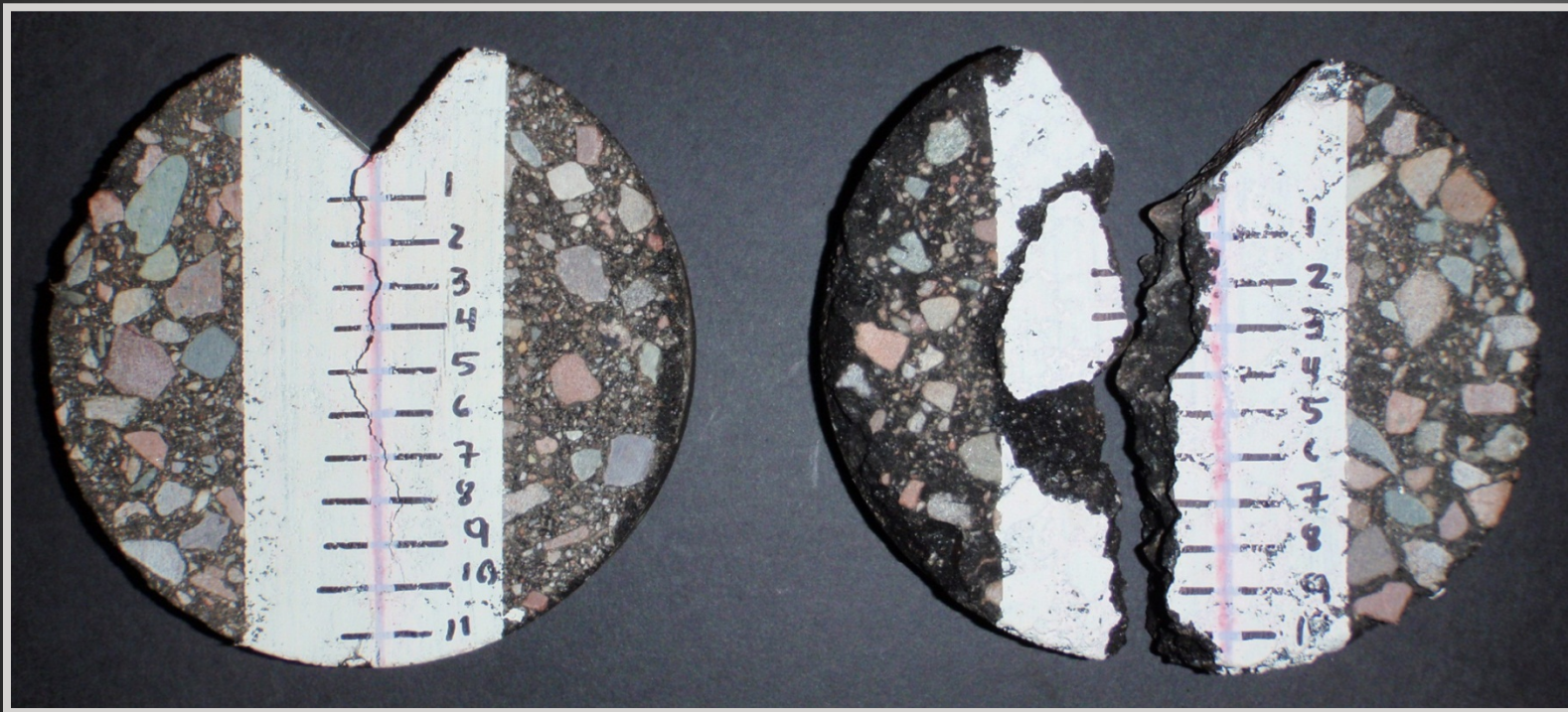
# Science Details

## Cracking Evaluation - Energy

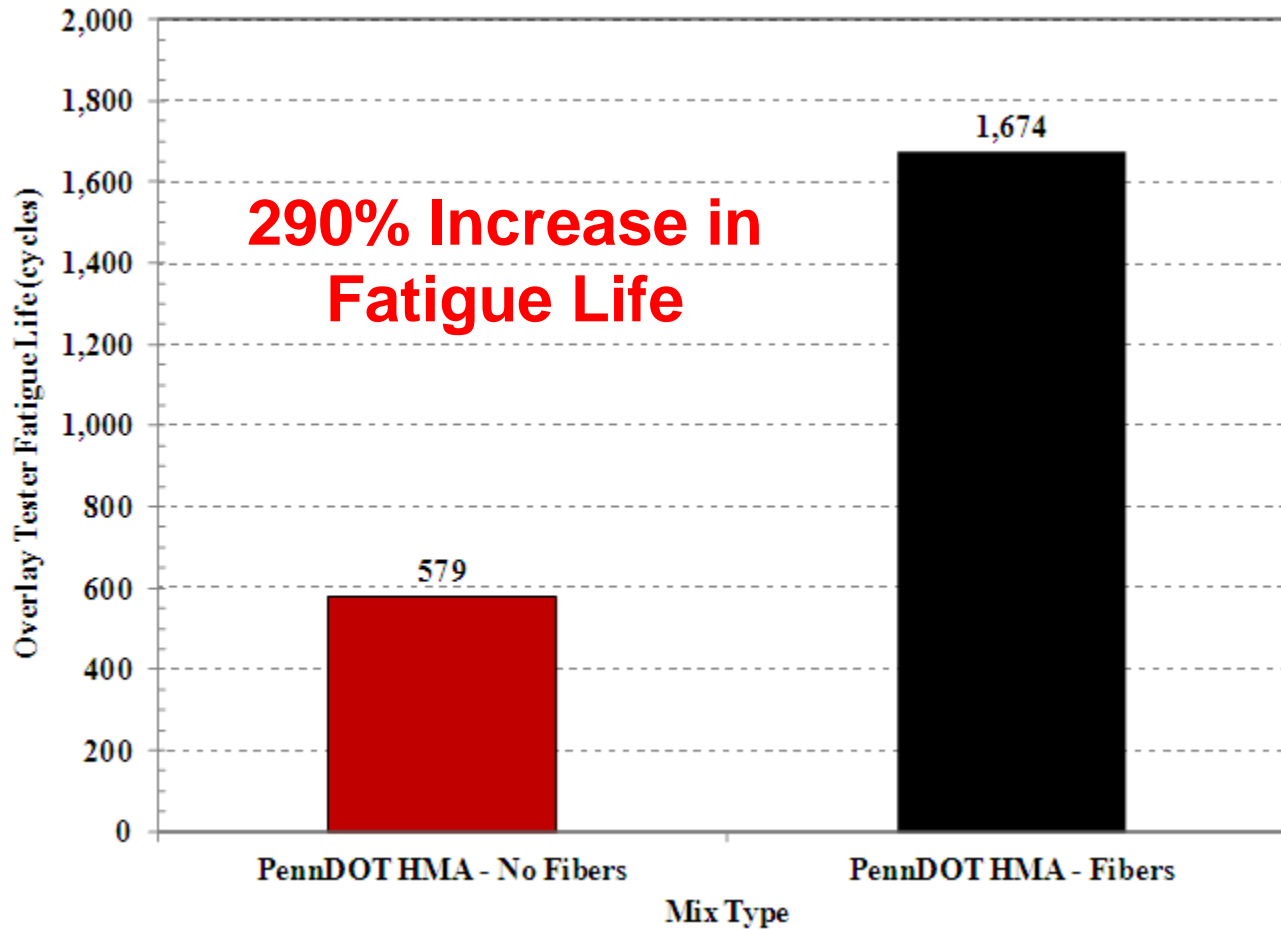


# Science Details

## Cracking Evaluation



# PennDOT Lab Tests



# Calibration to AASHTO and MEPDG Design Methods

Structural Layer Coefficient,  $a_1$ , for  
Asphalt Concrete Surface Course

$\approx 0.53$

$\approx 0.44$

| Temp. °F<br>(°C)             | Freq. Hz | Dynamic Modulus, MPa - ksi<br>(Test Values) |        |              |        | Modular Ratio<br>(Average 1.44) |
|------------------------------|----------|---|--------|--------------|--------|---------------------------------|
|                              |          | Fiber-Reinforced                            |        | Conventional |        |                                 |
| 14<br>(-10)                  | 25       | 7,029                                       | 48,463 | 6,059        | 41,775 | 1.16                            |
|                              | 10       | 6,511                                       | 44,892 | 5,587        | 38,520 | 1.17                            |
|                              | 5        | 6,279                                       | 43,293 | 5,500        | 37,920 | 1.14                            |
|                              | 1        | 5,815                                       | 40,090 | 4,983        | 34,356 | 1.17                            |
|                              | 0.5      | 5,577                                       | 38,449 | 4,776        | 32,926 | 1.17                            |
|                              | 0.1      | 4,987                                       | 34,384 | 4,212        | 29,037 | 1.18                            |
| 40<br>(4.4)                  | 25       | 5,308                                       | 36,596 | 4,191        | 28,897 | 1.27                            |
|                              | 10       | 5,132                                       | 35,387 | 4,027        | 27,768 | 1.27                            |
|                              | 5        | 4,812                                       | 33,178 | 3,793        | 26,149 | 1.27                            |
|                              | 1        | 4,238                                       | 29,218 | 3,204        | 22,089 | 1.32                            |
|                              | 0.5      | 3,958                                       | 27,289 | 2,940        | 20,270 | 1.35                            |
|                              | 0.1      | 3,325                                       | 22,927 | 2,357        | 16,247 | 1.41                            |
| 70<br>(21.1)                 | 25       | 3,197                                       | 22,045 | 2,258        | 15,566 | 1.42                            |
|                              | 10       | 2,924                                       | 20,160 | 1,967        | 13,563 | 1.49                            |
|                              | 5        | 2,669                                       | 18,403 | 1,760        | 12,137 | 1.52                            |
|                              | 1        | 2,119                                       | 14,610 | 1,287        | 8,870  | 1.65                            |
|                              | 0.5      | 1,853                                       | 12,773 | 1,108        | 7,637  | 1.67                            |
|                              | 0.1      | 1,294                                       | 8,920  | 759          | 5,230  | 1.71                            |
| 100<br>(37.8)                | 25       | 1,786                                       | 12,311 | 1,010        | 6,960  | 1.77                            |
|                              | 10       | 1,500                                       | 10,341 | 818          | 5,641  | 1.83                            |
|                              | 5        | 1,246                                       | 8,589  | 685          | 4,723  | 1.82                            |
|                              | 1        | 814   | 5,611  | 442          | 3,045  | 1.84                            |
|                              | 0.5      | 641   | 4,422  | 360          | 2,482  | 1.78                            |
|                              | 0.1      | 315   | 2,174  | 235          | 1,623  | 1.34                            |
| 130<br>(54.4)                | 25       | 616   | 4,249  | 387          | 2,668  | 1.59                            |
|                              | 10       | 466   | 3,214  | 294          | 2,024  | 1.59                            |
|                              | 5        | 374   | 2,578  | 247          | 1,702  | 1.51                            |
|                              | 1        | 232   | 1,596  | 173          | 1,194  | 1.34                            |
|                              | 0.5      | 194   | 1,335  | 156          | 1,076  | 1.24                            |
|                              | 0.1      | 138   | 949    | 130          | 893    | 1.06                            |
| <b>Average Modular Ratio</b> |          |   |        |              |        | <b>1.44</b>                     |

# Easily Implemented

- Mixes well in both Batch and Drum plants
- One bag / 1 lb. dosage per ton of asphalt
- Complete product range with (3) unique blends for specific applications
- Blends containing Kevlar® and polyolefin fibers and other materials packaged in polyethylene bags
- Mixes thoroughly in seconds, and distributes uniformly and completely





# Benefits – Easily Realized

- Significantly improves All structural properties of asphalt
- Calibrated for AASHTO & MEPDG Design Methods
- No modifications needed to current asphalt mix
- No modifications needed to asphalt plants
- No modifications needed to standard placement or compaction practices
- No new equipment or special training
- Tested to today's tough new industry standards
- Backed by Forta's 30 year history of successful Fiber use

# Current Forta-Fi Users

- City of Medford, OR
- City of Beaverton, OR
- City of Tigard, OR
- Ohio DOT
- Illinois DOT
- Georgia DOT
- Pennsylvania DOT
- Alabama DOT
- Jackson Hole Air
- Sheridan County
- City of Grove City
- City of Mesa, AZ
- Boeing Field, AZ



## ALABAMA DEPARTMENT OF TRANSPORTATION

Bureau of Research and Development  
1409 Coliseum Boulevard, Montgomery, Alabama 36130-3050  
Phone: (334) 353-6940 FAX: (334) 353-6950  
Internet: <http://www.dot.state.al.us>



Robert Bentley  
Governor

John R. Cooper  
Transportation Director

September 18, 2012

Tracy Long  
Forta Corporation  
100 Forta Drive  
Grove City, PA 16127

Re: PEB 2962: FORTA-FI HMA Blend

Dear Mr. Long:

On September 18, 2012, the Alabama Department of Transportation, Product Evaluation Board (PEB) approved the FORTA-FI HMA Blend for addition to the Department's Materials, Sources, and Devices with Special Acceptance Requirements Manual List II-23, Admixtures for use in Hot Mix Asphalt.

Thank you for the submittal of your product. If you have additional questions, please contact Ms. Michelle Owens or Mr. Ron Johnson at (334) 353-6940.

Sincerely,

Lamar S. Woodham, Jr., P.E./P.L.S.  
Chairman, Product Evaluation Board

LSW/JWB/JMO/RLJ

cc: Jeffery Brown, Research & Development Bureau Chief



# City of Medford La Loma & W. 2<sup>nd</sup> St.



# City of Beaverton

## Hocken Avenue



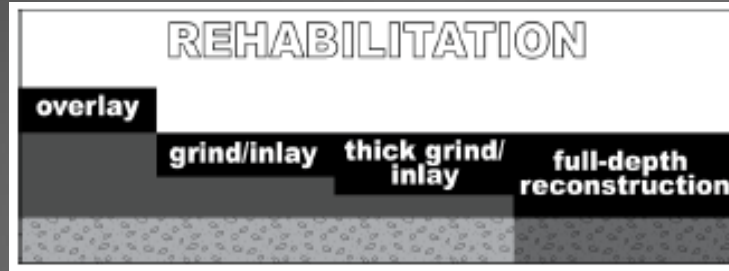


# City of Beaverton Lombard Avenue



# Value of Forta-Fi

Thickness Reduction = Cost Savings & Extended Life



Forta-Fi: \$10-\$12 per lb.

HMA: \$75 per ton

Standard AC

Forta-Fi AC

ESALs  $\triangle$

Cost  $\triangle$

1.5" Overlay

1.25"

55%  $\uparrow$

Equal

3.0" Overlay

2.0"

Equal

28%  $\downarrow$

**NET ZERO at Approx. 0.25" Reduction**

- Good Stewardship of Public Assets & Funds
- More Sustainable Solution
- Reduced Carbon Footprint



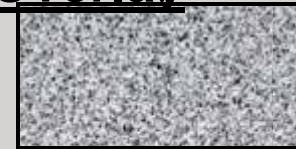


# 50% Asphalt Pavement Life Enhancement for

1. Reduce your overlay thickness 0.25";
2. The reduction in asphalt pays for Forta-Fi;
3. The thinner, but reinforced, asphalt section lasts 50%

**FREE**

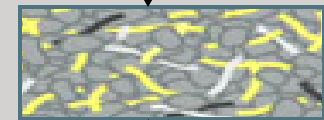
Standard Overlay



↑ 2"

680,000  
ESALS

Forta-Fi Overlay



↑ 1.75"

1,053,000  
ESALS

HMA=\$75/Ton & Forta-Fi=\$11/lb.  
Design Based on AASHTO

**FORTA-FI**®  
(Fiber Reinforcement Technology)

- Easy to specify
- Easy to construct
- Easy to justify

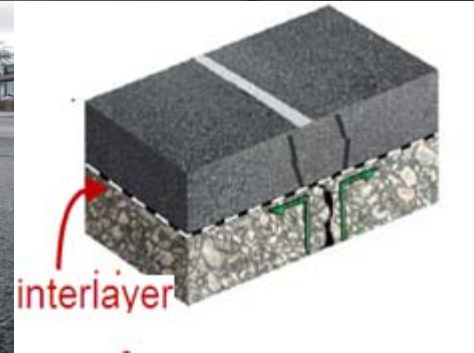


# Forta-Fi Advantages over Interlayers

## Three-Dimensional Reinforcement vs. Two-Dimensional

### More Benefits

- Resistance to All Cracking Types
- Rutting Resistance
- Raveling Resistance
- Extended Fatigue Life
- Less Asphalt
- Less Construction Time
- Quicker Compaction



### Quantified Benefits - MEPDG

- At Least 50% Increase in Pavement Service Life

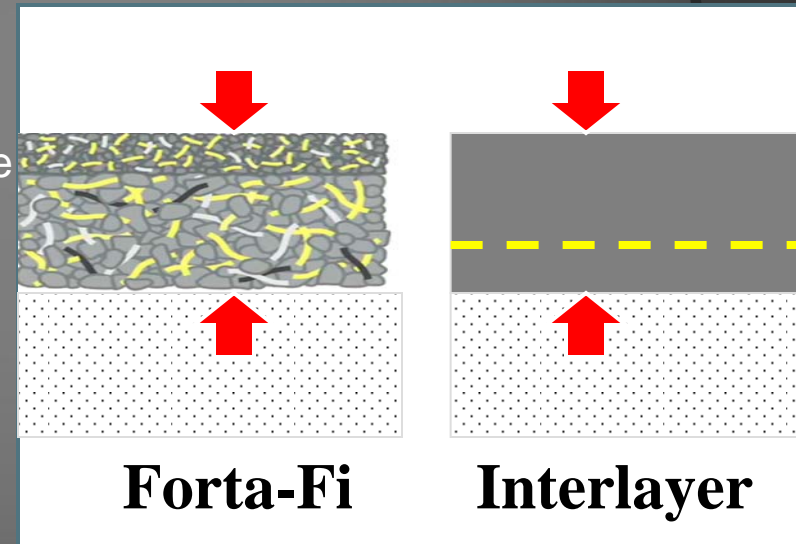
### Proven

- Every Project has Performed
- First-Time user's continue to use

### Easily Assimilated into Current Practices


- Contractor friendly
- Same paving procedure
- No Special Training
- No Special Equipment

### More Reasonably Priced (Approximately 1/3 the Cost)



# FORTA-FI Summary

## “Breakthrough” in Asphalt Performance



FORTA-FI saves money while improving the quality of our roadways

Can be immediately implemented by entire industry

Years of engineering, testing, trials and experience make FORTA-FI:

- Easy to use
- Easy to specify
- Easy to produce
- Easy to construct
- Easy to justify

# Thank you for your time!



**Joe Sturtevant, P.E.**  
1521 N. Jantzen Ave – Ste 117  
Portland, OR 97217  
[jas@jascompany.net](mailto:jas@jascompany.net)

**Phone: 503-568-2377**  
**[www.forta-fi.com](http://www.forta-fi.com)**